WHAT IS CLAIMED IS:

1. A method of making a metal part by semi-solid metal injection molding, comprising:

combining a first solid metal portion and a second liquid metal portion in a first chamber of an injection molding machine to form a semi-solid metal slurry; and

injecting the semi-solid metal slurry into a mold cavity to form a molded metal part.

- The method of claim 1, wherein:
 the first chamber comprises a shot chamber; and
 the semi-solid metal slurry is injected from the shot chamber into
 the mold cavity.
- 3. The method of claim 2, wherein the first solid metal portion is provided into the shot chamber before the second liquid metal portion is provided into the shot chamber.
- 4. The method of claim 3, further comprising:

providing a grain refining agent into the shot chamber before providing the second liquid metal portion into the shot chamber; or

providing the grain refining agent into the second liquid metal portion before providing the second liquid metal portion into the shot chamber.

- 5. The method of claim 4, wherein:
- a combined volume of the slurry comprising the grain refining agent, the first solid metal portion and the second liquid metal portion is substantially equal to a volume of the mold cavity; and

a latent heat of the second liquid metal portion is sufficient to bring a temperature of the combined volume into a semi solid state.

- 6. The method of claim 5, wherein the metal comprises aluminum or an aluminum alloy.
- 7. The method of claim 6, wherein the metal comprises a hypereutectic alloy.
- 8. The method of claim 7, wherein the metal comprises a 390 alloy.
- 9. The method of claim 8, wherein the temperature of the semi-solid metal slurry is between 560 °C and 590 °C.
- 10. The method of claim 7, wherein the grain refining agent comprises a phosphorus containing alloy or a phosphorous bearing salt.
- 11. The method of claim 10, wherein the grain refining agent comprises an alloy containing copper and phosphorus, an alloy containing aluminum, copper and phosphorus or a phosphorous-bearing salt.
- 12. The method of claim 6, wherein the metal comprises a hypoeutectic or a non-silicon bearing alloy.
- 13. The method of claim 12, wherein the metal comprises an A356 alloy.
- 14. The method of claim 13, wherein the temperature of the semi-solid metal slurry is between 575 °C and 585 °C.

15. The method of claim 1, wherein the first solid metal portion and the second liquid metal portion comprise the same metal or metal alloy.

- 16. The method of claim 1, wherein the first solid metal portion comprises a solid grain refining agent which is adapted to refine grains of a second metal alloy and the second liquid metal portion comprises the second metal alloy.
- 17. The method of claim 13, wherein the grain refining agent comprises an alloy containing titanium, or boron or combinations thereof.
- 18. The method of claim 5, wherein the first solid metal portion comprises 5 to 30 volume percent of the combined volume of the semisolid metal slurry in the shot chamber.
- 19. The method of claim 1, further comprising: removing a third solid metal portion of the molded metal part; and providing the third solid metal portion into the first chamber of the injection molding machine during a subsequent step of forming a subsequent molded metal part.
- 20. The method of claim 19, wherein the mold cavity includes a secondary cavity portion, the secondary cavity portion having a volume substantially equal to the third solid metal portion.
- 21. The method of claim 20, wherein the secondary cavity portion has a surface area to volume ratio of at least 5:1.
- 22. The method of claim 21, wherein the surface area to volume ratio is greater than 10:1.

23. The method of claim 21, wherein the secondary cavity portion contains fin or spike shaped regions to form the third solid metal portion having fins or spikes.

- 24. The method of claim 20, further comprising placing a grain refinement agent into the secondary cavity portion prior to injecting the semi-solid metal into the mold cavity, such that the grain refinement agent is entrapped in the third solid metal portion.
- 25. The method of claim 2, wherein the shot chamber comprises a vertically oriented shot chamber having a horizontal width that is at least two times greater than a vertical depth of melt in the chamber.
- 26. The method of claim 25, wherein:

the semi-solid slurry forms in the shot chamber with a generally globular or equiaxed primary phase microstructure without stirring the semi-solid slurry; and

the semi-solid slurry is injected into a mold cavity by advancing a shot piston upwardly in the shot chamber.

- 27. A molded metal part made by the method of claim 1.
- 28. The part of claim 19, wherein the part comprises a first region that is richer in primary particles than a second region.
- 29. A method of making a metal part by semi-solid metal injection molding, comprising:

providing a solid metal heat sink into a shot chamber of an injection molding machine;

providing liquid metal over the heat sink to form a semi-solid metal slurry; and

injecting the semi-solid metal slurry into a mold cavity to form a molded metal part.

30. The method of claim 29, further comprising

providing a grain refining agent into shot chamber before providing the liquid metal into the shot chamber; or

providing liquid metal including a grain refining agent.

31. The method of claim 30, wherein:

a combined volume of the slurry comprising the grain refining agent, the first solid metal portion and the second liquid metal portion is substantially equal to a volume of the mold cavity; and

a latent heat of the second liquid metal portion is sufficient to bring a temperature of the combined volume into a semi solid state.

32. The method of claim 31, wherein:

the metal comprises a hypereutectic aluminum alloy;

the temperature of the semi-solid metal slurry is between 505 $^{\circ}\text{C}$ and 600 $^{\circ}\text{C};$ and

the grain refining agent comprises a phosphorus containing alloy or a phosphorous bearing salt.

33. The method of claim 32, wherein:

the metal comprises a 390 aluminum alloy;

the temperature of the semi-solid metal slurry is between 560 °C and 590 °C; and

the grain refining agent comprises an alloy containing copper and phosphorus, an alloy containing aluminum, copper and phosphorus or phosphorous-bearing salt.

34. The method of claim 31, wherein:

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the metal comprises a hypoeutectic or a non-silicon bearing aluminum alloy;

the temperature of the semi-solid metal slurry is between 560 °C and 600 °C; and

the grain refining agent comprises an alloy containing titanium, or boron or combinations thereof.

35. The method of claim 34, wherein:

the metal comprises an A356 aluminum alloy;

the temperature of the semi-solid metal slurry is between 575 $^{\circ}\text{C}$ and 585 $^{\circ}\text{C}.$

- 36. The method of claim 31, wherein the heat sink comprises 5 to 30 volume percent of the combined volume of the semi-solid slurry in the shot chamber.
- 37. The method of claim 36, further comprising:

 removing an appendage from the molded metal part; and
 providing the appendage back into the shot chamber of the
 injection molding machine during a subsequent step of forming a
 subsequent molded metal part.

38. The method of claim 37, wherein:

the mold cavity includes a secondary cavity portion, the secondary cavity portion having a volume substantially equal to the appendage;

the secondary cavity portion has a surface area to volume ratio of at least 5:1.

- 39. The method of claim 38, further comprising placing a grain refinement agent into the secondary cavity portion prior to injecting the semi-solid metal into the mold cavity, such that the grain refinement agent is entrapped in the appendage.
- 40. The method of claim 29, wherein:

the shot chamber comprises a vertically oriented shot chamber having a horizontal width that is at least two times greater than a vertical depth of melt in the shot chamber;

the semi-solid slurry forms in the shot chamber with a generally globular or equiaxed primary phase microstructure without stirring the semi-solid slurry; and

the semi-solid slurry is injected into a mold cavity by advancing a shot piston upwardly in the shot chamber.

- 41. The method of claim 29, wherein the solid metal heat sink and the liquid metal comprise the same metal or metal alloy.
- 42. The method of claim 29, wherein the solid metal heat sink comprises a solid grain refining agent which is adapted to refine grains of a second metal alloy and the liquid metal comprises the second metal alloy.
- 43. A molded metal part made by the method of claim 29.
- 44. A method of making a metal part by semi-solid metal injection molding, comprising:

providing a solid metal heat sink into a shot chamber of an injection molding machine, wherein the shot chamber comprises a vertically oriented shot chamber having a horizontal width that is at least two times greater than a vertical depth of melt in the chamber;

providing a grain refining agent into shot chamber;

providing liquid metal over the heat sink and the grain refining agent to form a semi-solid metal slurry, wherein the semi-solid slurry forms in the shot chamber with a generally globular or equiaxed primary phase microstructure without stirring the semi-solid slurry;

injecting the semi-solid metal slurry from the shot chamber into a mold cavity to form a molded metal part having an appendage;

removing the appendage from the molded metal part; and providing the appendage back into the shot chamber of the injection molding machine as a heat sink during a subsequent step of forming a subsequent molded metal part.

45. The method of claim 44, wherein:

a combined volume of the slurry comprising the grain refining agent, the first solid metal portion and the second liquid metal portion is substantially equal to a volume of the mold cavity; and

a latent heat of the second liquid metal portion is sufficient to bring a temperature of the combined volume into a semi solid state.

- 46. The method of claim 44, wherein the metal comprises a hypereutectic alloy.
- 47. The method of claim 46, wherein:

the temperature of the semi-solid metal slurry is between 505 °C and 600 °C; and

the grain refining agent comprises a phosphorus containing alloy or a phosphorous bearing salt.

48. The method of claim 47, wherein:

the metal comprises a 390 aluminum alloy; and

the temperature of the semi-solid metal slurry is between 560 °C and 590 °C; and

the grain refining agent comprises a copper and phosphorus containing alloy.

- 49. The method of claim 44, wherein the metal comprises a hypoeutectic or a non-silicon bearing alloy.
- 50. The method of claim 49, wherein:

the temperature of the semi-solid metal slurry is between 560 °C and 600 °C; and

the grain refining agent comprises an alloy containing titanium, or boron or combinations thereof.

51. The method of claim 50, wherein:

the metal comprises an A356 aluminum alloy;

the temperature of the semi-solid metal slurry is between 575 °C and 585 °C.

- 52. The method of claim 45, wherein the heat sink comprises 5 to 30 volume percent of the combined volume of the semi-solid slurry in the shot chamber.
- 53. The method of claim 52, wherein:

the mold cavity includes a secondary cavity portion, the secondary cavity portion having a volume substantially equal to the appendage;

the secondary cavity portion has a surface area to volume ratio of at least 5:1.

- 54. The method of claim 44, further comprising placing a grain refinement agent into the secondary cavity portion prior to injecting the semi-solid metal into the mold cavity, such that the grain refinement agent is entrapped in the appendage.
- 55. The method of claim 44, wherein the solid metal heat sink and the liquid metal comprise the same metal or metal alloy.
- 56. The method of claim 55, wherein the solid metal sink further comprises a grain refining agent which is adapted to refine grains of a second metal alloy and liquid metal comprises the second metal alloy.
- 57. A molded metal part made by the method of claim 44.